The Builder.

No. CCXXIII.

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OUR readers will remember that in October last a cotton mill at Oldham, in Lancashire, fell, destroyed twenty persons, and injured many others.* Sir Henry De la Beche and Mr. Thomas Cubitt were appointed commissioners, by her Majesty's command, to collect evidence respecting its fall, and "to investigate into the causes connected with the structure of that building, or of certain parts thereof, which led" to the loss of life on that occasion. An inquiry into the circumstances which occasioned the failure of a part of the prison at Northleach, in Gloucester, was also referred to them. After examining the premises, and hearing such witnesses as were likely to afford the required information, they, at the end of February last, reported their proceedings and the results of their investigations.

This report is now before us: it contains some very valuable information, especially as to the strength of cast-iron beams, and some suggestions by Mr. Cubitt which should be acted on forthwith. In addition to parties connected with the buildings in question, they examined Mr. Fairbairn, Mr. Eaton Hodgkinson, and others, who have given attention to the forms of beams and the nature of iron, and have printed the minutes of evidence: the commissioners have further appended the results of a number of experiments made at Thames Bank, to shew the comparative strength of iron beams of different forms, already referred to in our pages.†

"It would appear that the Messrs. Radcliffe, who carry on an extensive business, had considered it expedient to add to their mill or factory, and for this purpose had undertaken the erection of two new buildings upon the principle termed fire-proof; that is, so combining iron, commonly cast-iron, with bricks or stone, as to exclude, or nearly exclude, wood in their erection, thereby rendering the building, as such, incapable of being consumed by fire. One of these buildings was erected over the space or area occupied by the boilers of the steam-engine, adjoining the old portion of the mill; the other, of larger dimensions, was, and is, to a certain extent separated from it.

At the latter end of October last the building over the boilers was completed, one 27½ feet high, including the roof, 77 feet long, and 41 feet wide. The other building, of larger dimensions, being unfinished, as it now is, though in a more advanced state than at that time. Prior to the former addition to the mill, the boilers, six in number, were covered by a fire-proof floor, formed of brick arches resting on cast-iron beams, the whole supported by the walls and cast-iron columns; and above this fire-proof floor there was a clear story, roofed with wood. This portion of the building had been erected eight years since by Mr. John Milnes, iron-founder, of Oldham.

When it was thought desirable to form an addition to the factory in this direction, enlarging that part of the old mill, the roof above noticed was removed, and the new work was carried up based upon the old (15 feet high). The same plan with respect to the arrangement of beams and arches was followed in the new floors, five in number, as in the old floors, the beams being, however, of less weight in the new work than in the old. Thus the building was a compound of work executed eight years since with that commenced in May last, the foundations and 15 feet of the height above the ground being of the former date."

"It was stated that the beams were all proved, that is, subjected to pressure to ascertain their strength, the pressure being usually beyond the weight which it is calculated that they would have to support, in accordance with the stipulation made with the founders, Messrs. Sevelles and Woolstanholme, by the Messrs. Radcliffe. The proof required was a load upon the centre of each beam, 14 feet long, equal to eight tons. The proof actually given is stated to have been equal to 9½ tons. John Swailes, joiner, in the employ of the Messrs. Radcliffe, and who made the patterns for the beams, deposes to have seen about twenty beams proved, a weight of 9½ tons being, he was informed at the time, applied to the centre of each. The same witness also states that he saw many of the beams cast, and that several were removed red-hot from the sand.

When not resting on the walls, where they were laid upon large stones, the beams were supported by cast-iron columns, cylindrical and hollow, 6 inches in diameter externally, and varying in weight from about 6 cwt. each in the lower floor, to about 5 cwt. each in the upper floors, those in the former having a core or hollow 4 inches in diameter, thus giving a thickness of 1 inch of metal; those in the latter, a core of 4½ inches, making three-quarters of an inch in metal. The upper columns, fitted by a projecting portion of their lower ends, into a corresponding socket in the highest part of those beneath them, and the beams were fastened to the columns by clips of wrought iron, secured red-hot over ears or projections at the extremities of the beams. The columns in the lowest floor rested upon iron plates, and these upon brickwork. The ties or rods connecting the beams together were about 4½ feet apart on the average, of wrought Staffordshire iron, seven-eighths of an inch square, and passed through the upper part of the beams, within about 1½ inch from the top.

The walls of the building were of the same thickness from the bottom to the top, 2½ feet thick for the side walls, and 2 feet thick at the end walls, and were constructed with bricks, sound and good. Two tiers of bond timber, 4½ inches by 3 inches, passed through the centre of the windows on each floor, and they were laid upon the same course, 4½ inches from both the outside and inside of the walls.

The arches of the different floors were of bricks, built with mortar made with Derbyshire lime; they rose in a span from 10½ feet to 11½ feet, and formed a regular segment of a circle. The upper course of bricks was wedged in tight with pieces of Welsh slate, and the whole was paved with flagging, about 1½ inch thick."

Such was the general constructinn and arrangement of the building, when one of the arches in the upper floor was observed to have settled about 4 inches, and workmen were employed to take it out, and replace it. While this was in operation one of the beams broke close to a column (from the lateral thrust of the adjoining arch as it is considered), and the whole building was almost instantaneously destroyed.

Witnesses were of opinion that this breakage of the beam, though sufficient to cause much damage, did not properly account for the total destruction of the building which ensued: they considered there was not sufficient strength in the beams generally.

"They also advert to the injudicious position of the tie rods which, though sufficient in number and strength, were situated too high up for resisting the strain of the arch. To resist that strain, they point out that the maximum effect would be produced by their attachment to the bottom flange of the beam, but that being inconvenient, they recommend that the ties should not be placed higher than the soffet of the arch, where they would perforate the neutral axis of the beam, that is, where, from vertical pressure, the tendency of the lower part of the beam to be disrupted and opened out is balanced by the opposite tendency on the upper part of the beam to be crushed inwards, thus affording sufficient security to the arch without injury to the strength of the beam.

Though they observed imperfections in the cast-iron columns, arising from the variable thickness of the metal, they were satisfied with them in other respects, at the same time stating their opinion that one inch more in diameter, with the same weight of metal, would have afforded greater strength and security."

The iron, on examination of fragments of the beams, was found to be of fair average quality, but the central parts were more highly crystallized than the internal parts, which led to the inference that the former had cooled more quickly than the latter; cracks were also observed, due to the same cause.

"In the evidence of John Swailes it is stated, that several of the beams employed in the portion of the factory which fell were taken out red hot from the sand in which they were cast, a sufficient reason for the appearances we have noticed, more especially, when it is considered that the parts of the beams were of variable thickness, not only the upper and lower flanges differing in this respect, but also the vertical portion connecting them. Under an equal temperature such parts would tend to become solid at variable times, the thinnest parts first, and even under the favourable circumstances of protracted cooling there would still be a disposition in the particles to adjust themselves unequally, producing unequal strains, and an absence of uniform structure in the mass. A fact well known to iron-founders, who from it, endeavour to arrange their castings, so as to obtain as much as possible a uniformity of thickness in the different parts.

The practice of removing beams of cast-iron, to be employed in sustaining weights, red hot from the sand, is very properly reprobated in the evidence of Messrs. Fairbairn and Whitworth. The former observes,—

'From my own experience, I am satisfied that fire-proof beams should never remain less than ten hours in the sand after they are cast; and for heavy castings thirty or forty hours, or more, are sometimes necessary to assist nature in a perfect, and, consequently, a strong and compact process of crystallization.'

We consider that even good cast-iron may be rendered comparatively brittle by sudden cooling, judging from what is known on the subject of the cooling of many substances, the more sudden application of cold to a substance in igneous fusion, producing the brittle quality, exemplified in the various glasses, more moderate cooling furnishing compactness, while more protracted refrigeration causes, in many bodies, crystalization, which may become of such an order from the occurrence of large crystalline planes, as to render fracture more easy in the line of such planes, being those of least resistance than in the intermediate state productive of compactness.

Unfortunately, it is considered a saving, particularly in small founderies, to remove castings red hot from the sand. Mr. Whitworth points out that not only is room acquired where it is so needed, in such founderies by this practice, but that a saving also is effected in the sand employed, which becomes burnt and destroyed near the castings while the latter are annealed in the cooling.

From at least several of the beams employed in the building which fell being, as stated by John Swailes, taken out red hot from the sand when cast, from the cracks and other corroborative proofs of rapid cooling observed by ourselves, and from having seen a beam cracked through the vertical portion connecting the upper and lower flanges, in the lower part of the larger fire-proof building now finishing, and in connection with the works of the Messrs. Radcliffe, this crack, or fissure, precisely of the kind that would be formed from an unequal tension of the thicker and thinner parts of the beam, more especially, if taken from the sand red hot and thus suddenly cooled; we are disposed to believe that similar rents or cracks may have occurred in many other beams."

Considering the evidence correct, the commissioners believe that the lateral pressure of each of the arches successively fractured the adjacent beams.

"This happening on the upper floor, there is little difficulty in conceiving that the mass of bricks and iron thus suddenly thrown upon the floor beneath would crush it, and this

* See Builder, Vol. II. p. 563.
† See p. 69 ante.

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